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50X1-HUM

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SUPPLEMENT TO REPORT NO.

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50X1-HUM

1. The Welding Department of The Central Scientific Research Institute of Technology and Engineering (TsNIITMash) at Moscow has for many years conducted investigations in the technology of welding of different kinds. These efforts have resulted in the introduction into industry of electrodes and fluxes of new types for manual and automatic elettric arc welding. Welding appliances and equipment of several types have been produced for welding under a layer of flux and for resistance welding, which are already operating in different branches of industry.

2. The Welding Department maintains close contact with other scientific institutions occupied with problems of welding, e.g., Electric Welding Institute of the Academy of Sciences of the Ukrainian SSR, Welding Section of the Academy of Sciences of the USSR, Welding Laboratory of NVTUB, Welding Laboratory of the Elektrik Works in Leningrad.

3. Attached to the department are the following laboratories:
   Laboratory of Electric Arc Welding
   Laboratory of Resistance Welding
   Welding Laboratory: studies other methods of welding, such as gas welding, atomic-hydrogen welding, etc.
   Laboratory of Electrodes and Fluxes

Personnel

4. The head of the Welding Department is Konstantin Antonovich Udotov, Stalin Prize Winner. Following are the names of other scientists and engineers

50X1-HUM

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working in this department:

Professor A.A. Alov, Dr. of Tech. Sc.
I.I. Brinberg, Cand. of Tech. Sc., Stalin Prize Winner
Professor A.S.Gelman, Dr. of Tech. Sc.
Professor Ya.M. Kuzmak, Dr. of Tech. Sc. (also works in other scientific institutions, e.g., Moscow Petroleum Institute imeni Gubkin)
Dotsent V.A. Lapidus, Cand. of Tech. Sc.
Professor K.V. Lyubavskiy, Dr. of Tech. Sc., Stalin Prize Winner

Engineer Ya.V. Ambramova
Engineer S.S. Astafev
Engineer A.A. Chekanov
Engineer V.P. Glukharev
Engineer L.V. Godub
Engineer I.N. Grabov
Engineer M.F. Khrobastov, Stalin Prize Winner
Engineer V.I. Klementov
Engineer-designer S.N. Komissarov
Engineer B.I. Lazarev
Engineer V.V. Orlov
Engineer F.I. Pashukanis
Engineer N.F. Prudnikov
Engineer P.G. Rybalka, Stalin Prize Winner
Engineer-designer Ya.Sh. Slepak
Engineer T.A. Vashurova
Engineer V.P. Yakushkin, Stalin Prize Winner
L.M. Yarovinskiy, Stalin Prize Winner

Activities

5. One of the important works accomplished by the department was the study of a method of automatic flux welding and bringing it up to industrial utilization standard. Although the main work in this field was performed in the Electric Welding Institute of the Academy of Sciences of the Ukrainian SSR, headed by Academician Ye.O. Paton (formerly for six years supervisor of the Welding Dept of TsNIITMash) the work performed in the Welding Department was no less important, because many of the problems were worked out on somewhat different lines.

6. Work on constructing equipment for automatic flux welding was started in the Welding Department as far back as 1941. Assimilation of this method of welding proceeded during the first years of the war on the lines of experimental selection of several alternative fusing agents and wires. Already in 1942 the first model was made of a traction welder (svarochny traktor) successfully adapted at the Uralmash Engineering Works. Intensive work on the improvement of automatic welding equipment began towards the end of 1943, when side by side with work on the design of new models, research work was also developed.

7. After the war, commencing in 1945, the systematic study of problems of automatic control of welding and of the theoretical causes of welding processes was begun.

8. The best specimens of native and foreign welding heads (svarochnaya golovka) and other appliances were tested. By 1946 and 1947 uncomplicated, reliable welding equipment was evolved by the department and adopted by many industrial enterprises, e.g., traction welder (svarochny traktor) UT-1200, traction welder UT-2000, welding head B, welding head V, and an appliance for seaming boiler joints (obvarka kotelnykh svyazey).

9. Traction welders UT-1500 and UT-1250, automatic welder SST-3, as well as manipulators and various other devices, were designed at a later date.

10. Following are some details of the above-mentioned welding equipment.

a. Welding Head (Svarochnaya Golovka), Type B

1) Used for automatic flux welding of butt - and T-joints of metal 2 to 20mm thick, longitudinal and circular seams.

2) Diameter of electrode wire: 3-6mm.

3) Strength of welding current: 300-1300 amps.

4) Electrode feeding speed: 0.32-1.66 meters per minute.

5) Dimensions of head, without panel and bunker: 45x330x245mm.

6) Weight of head, without panel and bunker: 16 kg.

7) Electric motor: type UM-22, 55 watts, 950 - 2250 r.p.m.

b. High-power Welding Head, Type V

1) Used for welding metal of great thickness on fixed mountings.

2) Diameter of electrode wire: 6-10mm.

3) Strength of welding current: 1,000-3,000 amps.

4) Electrode feeding speed: 0.5-2 meters per minute.

5) Regulation is done by means of an even change in the gear ratio of the speed variator and one pair of changeable pinions.

6) Maximum tractive force: 150 kg.

7) Dimensions: 885 x 775 x 335 mm.

8) Weight: 148 kg.

9) Electric motor: type 1-10/4, three-phase, asynchronous, 0.25 kw, 1,450 r.p.m.

c. Traction Welder (SvarochnyyTraktor), Type UT-1200

1) Used for automatic welding of butt and corner joints of a great variety of objects.

2) Diameter of electrode wire: 3-6 mm.

3) Strength of welding current: 300-1300 amps.

4) Speed of welding: 6-82 meters per hour.

5) Weight: 135 kg.

6) Capacity of flux holder: 12-14 kg.

7) Spare electrode wire in adapter: 8-12 kg.

8) The driving mechanism for shifting the tractor consists of a small asynchronous electric motor of 250 watts and 1,500 r.p.m., and a

gear box providing 16 speeds between 6 and 82 meters per hour.

9) The electrical equipment of the welding unit consists of welding transformers, regulators, contact-maker, current transformer, ammeter, voltmeter, etc.

d. Universal Traction Welder, Type UT-2000

1) Thickness of metal welded in one operation: 2-35 mm.

2) Diameter of electrode wire: 3-8 mm.

3) Strength of welding current: 300-2,000 amp.

4) Speed of welding: 10-330 meters per hour.

5) Weight: 130 kg.

6) Gauge of track: 230 mm.

7) Width of base of truck: 410 mm.

8) Capacity of flux holder: 10 kg.

9) Spare electrode wire in adapter: 3-12 kg.

10) For welding corner joints the welding head can be inclined to the required angle along or across the joint.

11) Electrical equipment: Welding transformers, regulators, contact-maker, current transformer, tension relay, two reversible starters, cut-out switches, safety fuses, electrical appliances for the control of the strength of welding current and arc tension, ammeter, voltmeter, control panel with six push-buttons and two change-over switches.

e. Boiler Joint Seaming Appliance (Apparat dlya Obvarki Kotelnykh Svyazey)

1) This is a small portable welding head used for contour seaming of boiler joints and similar parts having a diameter of 19-30 mm.

2) Diameter of electrodes: 4 and 5 mm.

3) Length of electrode: 450-500 mm.

4) Electrode feed for one turn round the joint: 79-115 mm.

5) Duration of one turn: 4.8 - 7.1 seconds.

6) Strength of welding current: 450-900 amps.

7) Dimensions: 410x250x245 mm.

8) Electric motor: three-phase, asynchronous, 100 watts, 1,500 r.p.m.

9) Electrical equipment: welding transformer, contact-maker, tension relay, terminals, etc.

f. Traction Welder, Type UT-1250 (1950)

1) This is an improved version of the 1949 type UT-1500.

2) Diameter of electrode: 2.5-6 mm.

3) Speed of welding: 13-83 meters per hour. 50X1-HUM

4) Strength of welding current: 300 to 1250 amps.

5) Weight of tractor: 44 kg.

6) Spare electrode wire in adapter: 10 kg.

11. All the welding heads and traction welders enumerated above have been and are being used with great success in many engineering works. Traction welders are being used in the Lyudinovo Traction-engine Works for the welding of rectilinear seams on the fire-box casing of the engine, Kherson Tractor-engine Works, Ordzhonikidze Works in Podolsk (for the welding of exterior and interior longitudinal boiler seams, and of circular drum seams), Novy Kramatorsk Engineering Works imeni Stalin, Elektrostal Works, and in many others. The boiler joint seaming appliance has been much utilized in factories making locomotive traction-engine boilers, and has eliminated the necessity of having highly skilled welders.

12. A range of high-grade electrodes for electric arc welding has been evolved in the Welding Department. Following are the names of some of the brands, together with the names of the engineers who have been responsible for their evolution.

a. TsSh-1, 2, 3, 4; TsL-2, 3, 4, 5, TsM-7.

b. TsI-1m, TsI-1ts. Alov and Sokolov.

c. OMM-1, 2, 3; OMU-1. A.A. Yerokhin.

d. OMA-2, OMG. N.A. Sokolov.

e. OMM-5. K.V. Lyubavskiy.

f. TsM-73. Alov.

13. Following are particulars of some of the above-mentioned electrodes:

a. OMM-2 is mainly used for welding low-carbon steel. Following are the constituents of its thick coating: 20.8 per cent titanium ore, 20.8 per cent kaolin, 29 per cent manganese ore, 16.8 per cent ferromanganese, 12.5 per cent starch (by weight). To this mixture is added 22 per cent by weight of liquid glass.

b. OMU-1 is mainly used for welding medium-carbon steel.

c. OMM-5 is mainly used for welding medium-carbon steel. Following is the composition of its coating: 37 per cent titanium ore, 13 per cent feldspar, 21 per cent manganese ore, 20 per cent ferromanganese, 9 per cent starch or wood meal. To this mixture 30 per cent of liquid glass is added. Wood meal is prepared by roasting pine sawdust without access of air, and then pulverizing it.

d. Electrodes TsSh-1, 2, 3, and 4 are used for building up (naplavka) the surfaces of worn-out and new stamps for drop forging. TsSh-1 is made of 3 KhVS, EI-160, and No.40 brands of steel. The thick coating is composed of 54 per cent marble, 23 per cent titanium ore, 10 per cent of granite (sic; misprint for graphite ?), 5 per cent ferromanganese, 8 per cent ferrochromium. Liquid glass is added to this mixture to the extent of 30 per cent.

e. TsSh-2 is made of 5Kh4M, 5KhGM, and similar steels.

f. TsSh-3 is made of 7 Kh-3 and similar steels.

g. TsSh-4 is made of ShKh 15.4 steel.

h. TsI-1m and TsI-1ts are used for building up cutting tools.

i. TsL-2, 3, and 4 are used for welding chrome-nickel stainless steel. The thick coating of TsL-4 is composed of 35.5 per cent chalk, 41 per cent titanium ore, 15 per cent molybdenum, 8.5 per cent ferromanganese, with an addition of 30 % of liquid glass to the mixture.

14. To improve the quality of electrodes and to increase the stability of the electric arc, special pressing devices have been designed by the department for coating electrodes with a special composition under high pressure. One such press of 1949 pattern coats up to 300 electrodes per minute. Another, an improved one of 1950 pattern, coats up to 500 per minute. These presses are already being used in many undertakings.

15. Big jobs have been carried out in the Welding Department in the investigation of fluxes for flux welding, and a number of types of flux have been evolved, which are at the present time being employed in numerous enterprises. One of the chief directors of this work was Professor V.K. Lyubavskiy. Fluxes of many different types, active, passive, high-manganese, non-manganese, etc, were all investigated.

16. Fused fluxes are manufactured in the department's laboratory. For this purpose the laboratory is specially equipped with an electric furnace with a shaft of shaped graphite brick (shakhta iz fasonno-grafitovogo kirpicha), ball mills for grinding components, sifting screens, driers, etc. Following are brief particulars of some of the fluxes:

a. AN-3 flux, used for welding low-carbon and low-alloy steels by means of a low-carbon or manganese silicate electrode wire, is composed of 50 per cent silica, 18 per cent limestone, 16 per cent manganese ore, 9 per cent dolomite, 3 per cent fluorspar, 4 per cent impurities.

b. OTs-45 flux, used for welding low-carbon steel with a low-carbon electrode wire, is composed of 45 per cent manganese ore, 40 per cent silica, 10 per cent fluorspar, 5 per cent impurities.

c. Slag flux ASh type, supplied by the Asha Metallurgical Works, was improved by the introduction of new components. It is now composed of 45 per cent silica, 13 per cent manganese ore, 30 per cent limestone, 12 per cent aluminum oxide.

17. The following is a description of a three-phase spot welding machine.

a. The Welding Department carried out a great deal of work in the investication of resistance welding, which resulted in the production of several machines and appliances for industry. The leading role of studying problems of spot welding is played by Professor A.S. Gelman. In 1950 a three-phase spot welding machine was designed under his guidance. This machine, after testing, went into industrial use.

b. The three-phase spot welding machine is intended for welding steel parts up to 12 mm thick. Following are some particulars:

1) Maximum power: 250 kva.

2) Maximum thickness of each part welded: 12 mm.

3) Maximum distance between electrodes: 400 mm (the electrodes are water-cooled)

4) Maximum force on electrodes: 10,000 kg.

50X1-HUM

5) Pressure in air circuit: 5 atmospheres.

6) Dimensions: height - 1,825 mm; width - 1,050 mm; depth - 2,300 mm.

c. Low-frequency current is used in the welding circuit. Current of industrial frequency is transformed into low-frequency current by means of a six-phase ignitron rectifier and an ignitron inverter. The rectifier's ignitrons are fed from the six phases of the secondary winding of an anode transformer. Ignition of ignitrons is effected by thyratrons. There is also a special low-power rectifier with a two-anode kenotron 5 Ts4S.

d. The welding assembly consists of two parts, the machine proper and the controlling devices. The welding transformer is fixed within the machine. The distance between the electrodes, which are located on the lower and upper arms of the machine, can be changed and may be made as high as 400 mm. The lower electrode-holding arm is controlled pneumatically. The upper arm is raised and lowered hydraulically.

e. To obtain the force necessary to bear on the electrode during welding, maximum 10,000 kg, oil under a pressure of 200 atmospheres is introduced into the hydraulic cylinder of the upper arm. The required oil pressure is developed in a hydro-pneumatic transformer attached to the air circuit of five atmospheres pressure.

f. A thermoregulator of TsNIITMash pattern is connected with the welding control circuit to compensate any possible variations of the current.

g. The whole welding operation has been made automatic. It is controlled by seven-step electric relays of time and a system of intermediate relays.

h. The ignitrons used in the machine are of the IG-1, IG-2, IG-3, IG-4, and IG-100/1000 types.

50X1-HUM

Comment: The general organization and activities of the Central Scientific Research Institute of Technology and Engineering (TsNIITMash), of which the Welding Department forms a part

50X1-HUM